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(54) Watt-hour meter

(57) A watt-hour meter system for measuring, processing and displaying the power consumption of each of a group of users, comprises, for each user, an electromagnetic ring sensor 1 which senses current consumption and means for sequentially reading the values from sample-and-hold circuits 3 into a CPU 11 under the control of multiplexer 14, 21. The voltage is also read in at 4 and the CPU calculates the consumption and displays it on display 16 and/or printer 17.

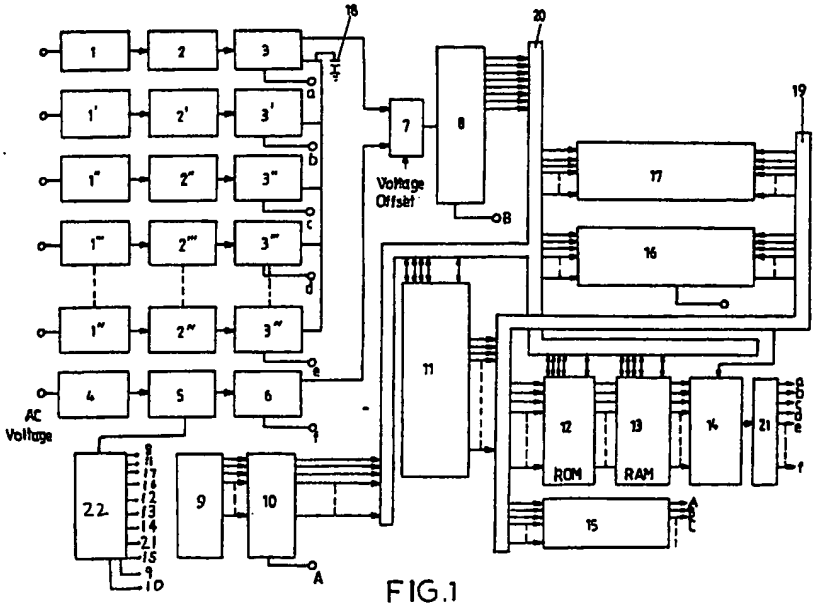

FIG.1

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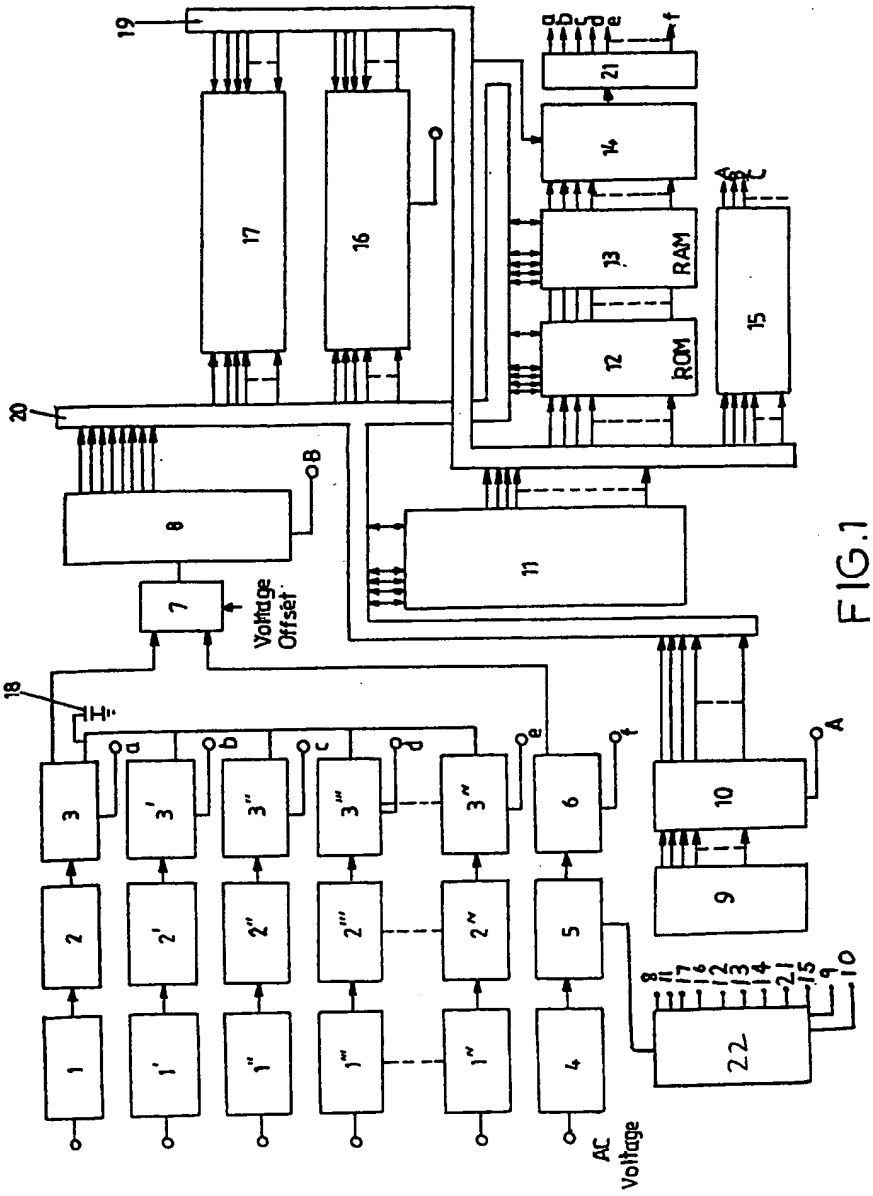
19
20
18
17
16
21
14
13
RAM
12
ROM
15
11
8
7
Voltage Offset
B
A
C
a
b
c
d
e
f
3
3'
3''
3'''
3''''
6
10
9
2
2'
2''
2'''
2''''
5
1
1'
1''
1'''
1''''
4
22
AC Voltage

FIG.1

SPECIFICATION

Watt-hour meter

The present invention concerns a watt-hour meter system, in which the power consumption of each individual user is sensed by a plurality of electromagnetic rings and the sensed signal is rectified, filtered and stored and the current and voltage data of each individual user are separately fetched in connection with a one-shot trigger device driven by a multiplexer control device. After conversion into digital signals via an analog-digital converter, such data are delivered to a CPU for processing, thereby recognizing the consumption of each individual user, and therefore the electric rate to be paid therefor both of which can be shown by a display or in a printed list.

Electricity is by far the most important energy source everywhere in modern living and the consumption of individual users has long been measured by watt-hour meters, which are invariably of a mechanical type, involving a magnetic field, a rotor bearing, and mechanical counters, etc. Despite the long history of the use of such mechanical watt-hour meters, they suffer several disadvantages which have never been obviated. The friction resulting from the transmission between the mechanical components not only causes the additional consumption of power of the whole apparatus, but also renders unavoidable mechanical errors after a long term use, which necessitates periodical re-adjustment and correction for a more precise measurement.

Moreover, the tiny digits of the mechanical counter are difficult to read with unaided bare eyes, causing much inconvenience in use. In recent years, an LED display has been introduced to replace the mechanical counter, yet the awkward conventional manner of separate measurement of each individual user still remains unimproved.

Known watt-hour meters can only test the power consumption of a single user's family, and the work of periodical inspection and recording are exclusively done by personnel (electric meter readers) from door to door. This work requires much labour, and is prone to cause personal mistakes. The electricity supplier (electric companies) have to hire many employees to do this work, thereby increasing the cost of electricity.

Accordingly, it is the chief object of this invention to provide an improved watt-hour meter, whereby the foregoing drawbacks of conventional means are obviated or mitigated.

In US Patent 3,961,317, there was disclosed a system for remote reading meters of consumable sources, wherein the flux of the consumable agent is sensed in a totally different manner. In its particular application in electricity measurement, the rotation of wheels is involved. Thus the system still suffers the mechanical problems of conventional electric meters. In the applicant's invention, all mechanical connections are eliminated and the functions are carried out electronically or microelectronically to obviate the otherwise unavoidable problems.

According to the invention, there is provided a watt-hour meter system for measuring, processing recording, and displaying the information of power consumption of any specified user out of a plurality of users, comprising:

a microcomputer system comprising CPU, memory and display;

a one-shot trigger means for each user's line;

there being provided for each user's line a sensor comprising an electromagnetic ring which can be attached to the line of the specified user in a manner that it is electromagnetically inductible by the current of said line;

there being provided for each user's line a separate current sampling circuit comprising said sensor, rectifier and filter means, and sampling and holding means;

the induction of said electromagnetic ring by the current passing through said line being in proportion to the latter, and providing an AC voltage signal which is rectified and filtered by said rectilier and filter means and converted into a DC voltage signal which is in turn sent to a sampling and holding means to be output therefrom when triggered by said one-shot trigger means to give an output of the signal representing the current of the specified user;

there being provided a voltage sampling circuit comprising attenuator means, rectifier and filter means, and sampling and holding means;

the sampled voltage being reduced by said attenuator, rectified and filtered by said rectifier and filter means and converted into a DC voltage which is in turn sent to the sampling and holding means as the data of the voltage of the user's line to be given out when triggered by the corresponding one-shot trigger means as the reference voltage signal of the user's line, and serving as the power supply for the whole system;

and a sequence control circuit comprising a multiplexer control device and said one-shot trigger means, which can give separate sampling signals in sequence in connection with the command of said microcomputer system to fetch the voltage data or current data of any specified user and feed them to the CPU for calculating the accumulated power consumption and corresponding data of the specified user and reveal the result in a readable manner.

According to the preferred embodiment, there is provided a watt-hour meter system

which detects the electricity of each individual user, transforming the data into signals, which are, in turn, filtered, rectified, stored, and sampled in connection with a one-shot trigger device driven by a multiple-function control device. The fetched data is compared with an offset voltage via an analog subtractor to adjust its output level and converted into digital signals by means of an analog/digital converter, and then led into a data bus to reach a CPU for arithmetical operation to respectively obtain the power consumption of each user, and therefore, the corresponding electric rate, the data of which can be shown on a display and/or printed out.

According to a further feature of this invention there is provided a watt-hour meter system which is adapted to a big building, e.g. a mansion, which is occupied by tens of families, or groups, such as companies. The data of all the users (here the term "user" refers to an individual unit that pays for a periodical power consumption) in a building are all monitored by the microprocessor system. This can effectively avoid the otherwise inevitable personal mistakes.

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawing, in which:

Figure 1 is a block diagram of a watt-hour meter according to this invention.

With reference to Fig. 1 the data of power consumption and electric rate of each user are measured by a microcomputer system, in which a CPU 11 is responsible for the control of the whole system and driven by a program stored in ROM 12. Inasmuch as the energy consumption is the product of current, voltage and time, the way to measure these factors are respectively described as follows.

A plurality of sensors 1, 1′, 1″ . . . each include an electromagnetic ring provided with coils and adapted to be hooked around one of the leads of the user's source in electromagnetically inductible manner. When a current passes through the lead, a magnetic field occurs therearound and can be sensed by the coils from the magnetic flux thereby produced, and the sensed data is transformed into alternating voltage by means of a current-voltage converter.

Full wave rectifier and filter means 2, 2′, 2″ . . . serve to rectify and filter the alternating voltages from sensor 1 and then convert them into DC signals.

Sampling and holding devices 3, 3′, 3″ . . . serve to store the thus obtained DC signals, which are held across the holding capacitor 18, and each individual unit is driven by one-shot trigger means 21 to give an output of DC voltage signals.

With the above means, the current passing through the circuit of each user can be known. Similarly, the voltage of each user can be obtained from the lead at the electromagnetic ring, and the sensed AC voltage of the users, e.g. 110V or 220V, is attenuated by attenuator 4, and the attenuated AC voltage is then converted into DC voltage of about 3 to 5 volts by means of full wave rectifier and filter means 5 and delivered to sampling and holding device 6, where it is stored as data which is output when driven by one-shot trigger means 21. The rectified, low DC current is also supplied to power supply unit 22 and serves as the source for energizing the whole microcomputer system, including CPU 11, ROM 12, RAM 13, multiplexer control means 14, and display 16.

When the whole system starts to work, CPU 11 will measure the power consumption of each user, following the sequence hereunder:

STEP 1: Firstly, CPU 11 sends an address data to the line control multiplexer 14, then one of its output lines will activate the subsequent one-shot trigger 21, which in turn, gives a pulse which gates sample-and-hold device 3. The current flow of the user's line can be sensed by the electromagnetic ring of sensor 1 and converted into an AC voltage, which, after passing through a full-wave rectifier and capacitor filter 2, is converted into a DC voltage across holding capacitor 18 of the sample-and-holding device 3. Since the holding capacitor 18 is shared by various lines, the DC across it is exactly in proportion to the current flow of the user's line of which the sample-and-hold device 3 is activated by CPU 11.

STEP 2: The sampled voltage is subtracted by an offset voltage by means of an analog subtracter 7 to adjust its output level. Then CPU 11 sends an address to decoder 15 which activates the strobe of converter 8. As a result, the corresponding digital data of the DC voltages are loaded into the data bus 20.

STEP 3: CPU 11 fetches the desired data from data bus 20. After a few arithmetic operations, using the existing data in the memory, all the information of a specified user (power consumption, electric rate, and so forth) can be calculated and updated again without any probable mistakes which often occur in the past.

STEP 4: CPU 11 repeats the above three steps to obtain the other users' information in like manner.

According to this invention, only one line for voltage measurement, by which the 110V or 220V AC voltage is fed to attenuator 4, is required by making use of one of the N user lines. By the same steps as described hereinbefore, CPU 11 can convert the AC voltages into corresponding digital data. From the data of the current, a user's power consumption can be known.

In use, it is noteworthy that the voltage data must be read into the system each time before CPU 11 starts to process the current

data.

After the power consumption and electric rate of each user has been measured and calculated, CPU 11 will send an address to the decoder 15, which in turn actuates data latch 10. In so doing, any key-in data can update the status of the information being displayed. Then CPU 11 sends another address to decoder 15 to actuate display 16, which displays the data from RAM 13 in association with the status of the information being displayed. Thus any information of the user's line can be revealed from the display digitally and from printer 17.

Having done the above jobs, a task cycle is completed. CPU 11 starts a measurement of another user's line. Since the duration of each cycle is definite, the power consumption can be calculated by the following formula:

$$\text{Power Consumption} = K \times \text{Current Data} \times \text{Voltage Data} \times \text{Cycle Duration}$$

where K is a proportionality constant, and the total power consumption for each user can be accumulated.

CLAIMS

1. A watt-hour meter system for measuring, processing recording, and displaying the information of power consumption of any specified user out of a plurality of users, comprising:

a microcomputer system comprising CPU, memory and display;

a one-shot trigger means for each user's line;

there being provided for each user's line a sensor comprising an electromagnetic ring which can be attached to the line of the specified user in a manner that it is electromagnetically inductible by the current of said line;

there being provided for each user's line a separate current sampling circuit comprising said sensor, rectifier and filter means, and sampling and holding means;

the induction of said electromagnetic ring by the current passing through said line being in proportion to the latter, and providing an AC voltage signal which is rectified and filtered by said rectifier and filter means and converted into a DC voltage signal which is in turn sent to a sampling and holding means to be output therefrom when triggered by said one-shot trigger means to give an output of the signal representing the current of the specified user;

there being provided a voltage sampling circuit comprising attenuator means, rectifier and filter means, and sampling and holding means;

the sampled voltage being reduced by said attenuator, rectified and filtered by said rectifier and filter means and converted into a DC voltage which is in turn sent to the sampling and holding means as the data of the voltage of the user's line to be given out when triggered by the corresponding one-shot trigger means as the reference voltage signal of the user's line, and serving as the power supply for the whole system;

and a sequence control circuit comprising a multiplexer control device and said one-shot trigger means, which can give separate sampling signals in sequence in connection with the command of said microcomputer system to fetch the voltage data or current data of any specified user and feed them to the CPU for calculating the accumulated power consumption and corresponding data of the specified user and reveal the result in a readable manner.

2. A watt-hour meter system as claimed in claim 1 wherein each said sensor comprises an electromagnetic ring and a current/voltage converter.

3. A watt-hour meter system as claimed in claim 1 or 2 comprising an output devices a visually readable display and a printer.

4. A watt-hour meter substantially as hereinbefore described with reference to the accompanying drawing.

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